THE SPECTROANALYSIS OF DDT AND ITS DEGRADATION PRODUCTS IN THE LARGE MILKWEED BUG

BY

WILLIAM CLYDE FERGUSON

B.S., Pennsylvania State College, 1937

M.S., Ohio State University, 1939

AN ABSTRACT OF A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN ENTOMOLOGY IN THE GRADUATE COLLEGE OF THE UNIVERSITY OF ILLINOIS, 1947

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The development of a color test for DDT and certain of its suspected metabolic products by Schechter *et al.* made it possible to study certain aspects of DDT metabolism in the large milkweed bug. When injected in emulsified peanut oil solution 170 mgm. of DDT was required to produce an LD-50 in this insect within 96 hours after treatment. Only 60 mgm. of DDT per gram of bug was required to produce the same degree of mortality in 24 hours when the compound was applied in acetone solution. Analyses made on treated insects showed that the milkweed bug metabolized about 43 per cent of a 100 mgm. per gram of bug dosage of DDT applied in an emulsified peanut oil solution within 1½ hours after injection, and a period of 48 hours was required for the insects to metabolize an additional equivalent amount. On the other hand, identical dosages of DDT applied in acetone solutions were metabolized to the extent of 80 to 100 per cent within 1½ hours after injection. It would, therefore, appear that peanut oil has the effect of limiting the availability of DDT to the metabolizing mechanism and at the same time acts to protect the insect from the potential toxicity of the injected dose. The ability of the insect to completely metabolize a lethal dose of DDT in a relatively short period of time would indicate that the prolonged fatal poisoning symptoms of DDT are the result of the presence of unmetabolized DDT for a period of short duration unless a metabolite of DDT should be responsible for the toxic effects of the compound.

DDT applied in acetone solutions at a dosage of 200 mgm. per gram of bug resulted in the metabolization of only 54 mgm. or 27 per cent of the total dosage within 1½ hours. Thus, DDT dosages in excess of the maximum which the insect can readily metabolize have the effect of inhibiting the DDT metabolizing mechanism. These results also indicate that DDT as such and not a DDT metabolite is responsible for the poisoning symptoms observed in treated insects.

It was found possible to recover nearly theoretical quantities of unchanged DDT from bugs killed by boiling for 3 minutes in water before injection with DDT acetone solution. Homogenized tissues of bugs treated with various quantities of DDT were also found to yield practically theoretical quantities of unchanged DDT. It is therefore concluded that the metabolization of DDT is dependent upon the intact living organism for the normal rate of DDT metabolism to occur.

Colorimetric and ultraviolet spectroanalyses of both solvent and water extracts of bugs treated with DDT failed to show the presence of the expected metabolites, namely DDE(2,2′-(bis-chlorophenyl)-1,1 dichloro-

ethylene) and DDA(2,2′-bis(p-chlorophenyl acetic acid)) which have been recovered from various tissues and products of DDT treated warm blooded animals. When DDE was injected into the milkweed bug in acetone solutions at dosage levels of 100 mgm. per gram of bug it was possible to recover a product which by the Schechter method of analysis appeared to be DDE, but upon examination of the extract in the ultraviolet spectrophotometer it was found to contain in addition to DDE an unknown compound suspected of being a DDE metabolite with a peak absorption of 2325 Å. The fact that DDE can be recovered in substantial quantities as long as 24 hours after it is injected into the bug is considered to be good evidence that DDT does metabolize stepwise from DDE to DDA in the milkweed bug or the presence of DDE in extracts of DDT treated insects would have been observed.

Milkweed bugs injected with DDA at dosages of 100 mgm. per gram of bug, extracted and analyzed 1½ hours later showed that 72 to 100 per cent of the DDA dose was not recovered. Since the compound could be recovered in near quantitative amounts from treated dead insects and bug *bries,* it may be concluded that DDA is not an end product of DDT metabolism in this insect, and that like DDT it is readily metabolized by the treated living insect.

One other suspected degradation product of DDT, namely, p,p′-dichloromethane could not be detected in the analyses of DDT treated insects and like DDA was found to be quickly metabolized by the living insect.

VITA

William C. Ferguson was born September 20, 1915, at Detroit, Michigan. He received his grammar school and high school education at Pittsburgh, Pennsylvania. In 1933 he enrolled at the Pennsylvania State College where he graduated in 1937 with a B.S. degree with a major in entomology. The summer and fall following graduation were spent working on the control of turf insects affecting the greens and fairways of golf courses in the Philadelphia, Pennsylvania, area.

From 1937 to 1938 he was employed by the Pittsburgh Coal Carbonization Company to conduct insecticidal investigations for the possible uses of tar oils and their by-products.

He received his M.S. degree in entomology from Ohio State University in 1939. During this time he held an industrial research fellowship sponsored by the Pittsburgh Coal Carbonization Company. The subject of his Master's thesis was "Low Temperature Tar Oil as a Tree Spray Oil."

From 1942 to 1944 he was employed by the Atlas Powder Company where he carried on developmental work with insecticides.

In 1944, he accepted a research fellowship sponsored by the Koppers' Company at the University of Illinois.

He is a member of the American Association of Economic Entomologists, Sigma Xi, Gamma Sigma Delta, and Phi Sigma.